

# Angle Lake Water Quality

*A Report on Water Quality Monitoring Results  
for Water Year 2009 at Angle Lake*



*Angle Lake*

Prepared for the City of SeaTac  
*by the King County Water and Land Resources Freshwater  
Program*

January 15, 2010



**King County**

## Overview

The King County Lake Stewardship Program (KCLSP) began working with volunteer monitors to monitor Angle Lake in 1994, although monitoring data collected by METRO goes back as far as the 1970s. There was a break in monitoring during 1996, but work resumed in 1997. In 2005, the City of SeaTac contracted with KCLSP to continue monitoring Angle Lake. During the 2009 water year, the KCLSP was folded into the King County Water and Land Resources Freshwater Program and monitoring on Angle Lake continued as in previous years. The water quality data indicate that currently the lake has low productivity categorized as oligotrophic, with very good water quality.

Angle Lake has a popular public access boat ramp, and residents may want to monitor aquatic plants growing nearshore to catch early infestations of Eurasian milfoil, Brazilian elodea or other noxious aquatic weeds.

This report refers to two common measures used to predict water quality in lakes. The Trophic State Index or TSI (Carlson 1977) is a method of calculating indicators from collected data that allows comparison between different parameters and predicts the volume of algae that could be produced in the lake. A second measure is the nitrogen to phosphorus ratio (N:P), which is used to predict which groups of algae may become dominant in the lake during the sample period. Both the TSI and N:P ratios have been calculated using the available data collected through the volunteer monitoring program.

The discussion in this report focuses on the 2009 water year. Specific data used to generate the charts in this report can be downloaded from the King County Lake small lakes data website at:

<http://your.kingcounty.gov/dnrp/wlr/water-resources/small-lakes/data/default.aspx>

Or it can be provided in the form of excel files upon request.

## Physical Parameters

Excellent records of precipitation and water level were kept over the 2009 water year (October 1, 2008 – September 30, 2009; Figure 1). The lake level followed a pattern commonly found in the Puget lowlands of winter high to summer low stands, with some sensitivity shown to inputs from large rain events, particularly in winter.

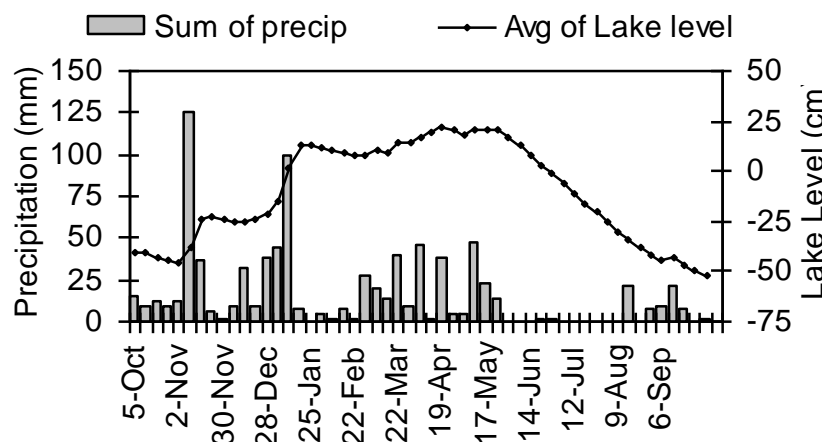
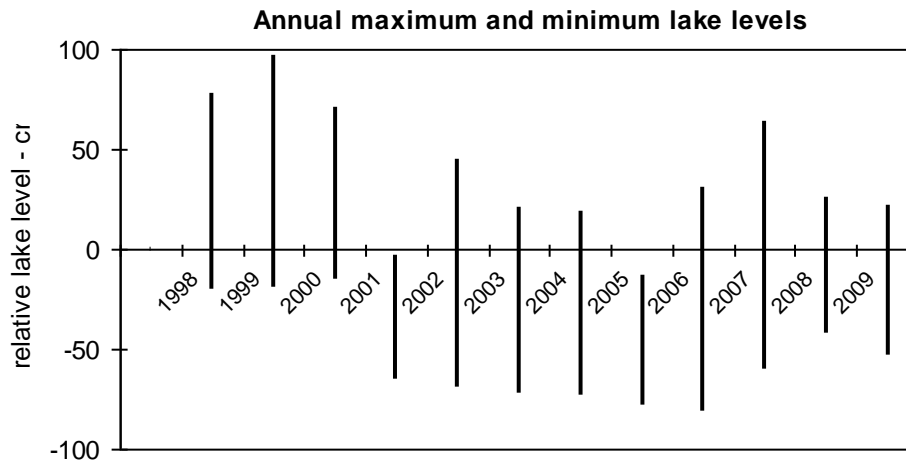


Figure 1. Angle Lake precipitation and lake level

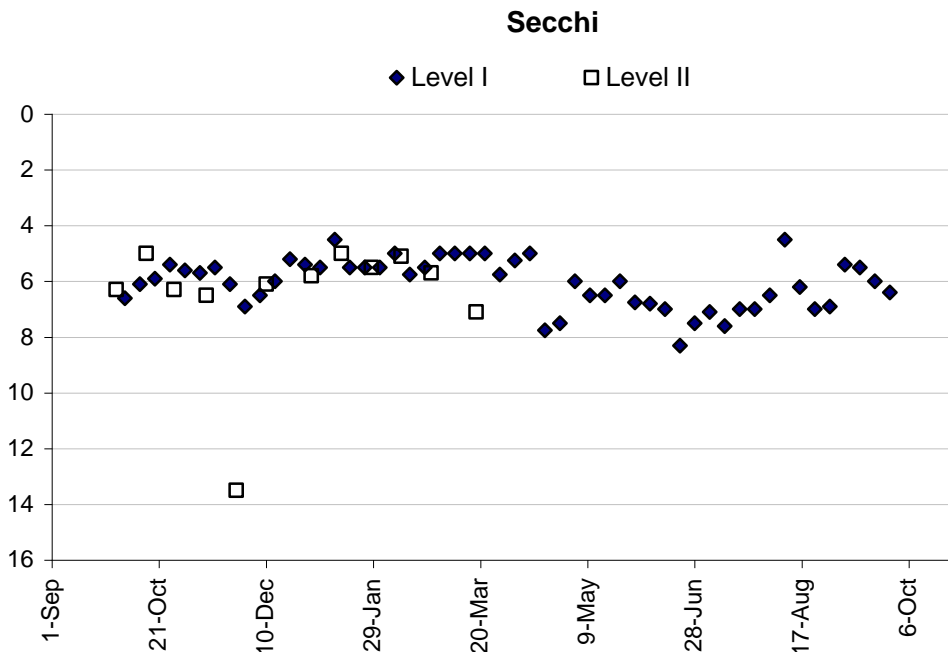
Lake levels also continue to fluctuate greatly from year to year, both in range and in the height of the maximum and minimum. This highly variable pattern appears to have begun in 2001 after 3 years of monitoring had produced fairly consistent maxima and minima in 1998-2000 (Figure 2).



**Figure 2. Each vertical line represents the range of lake levels recorded each water year relative to a zero datum set by a meter stick affixed to a static dock (not floating).**

**Secchi transparency** is a common method used to assess and compare water clarity. It is a measure of the water depth at which a black and white disk disappears from view when lowered from the water surface.

For Angle Lake, Secchi transparency values ranged from 5.0m to 8.0m, averaging 6.0m (Figure 2, symbols differentiate the two observers on the lake). Angle Lake ranked as one of the clearest small lakes monitored in King County in 2009.



**Figure 2. Angle Lake Secchi Transparency**

The Secchi transparency values exhibited the normal and expected variability through the season when compared to data collected in previous years.

**Water temperatures** during the water year followed a pattern similar to other lakes in the region, with cool temperatures in the winter and spring, followed by summer maximum temperatures occurring between mid-July and mid-August, and temperatures cooling in the fall. Angle Lake temperatures ranged from 4.0 to 25.0 degrees Celsius with an average temperature of 14.0 degrees Celsius (Figure 3). Compared with other lakes monitored through in 2009, Angle Lake is generally in the mid range of summer temperature maxima.

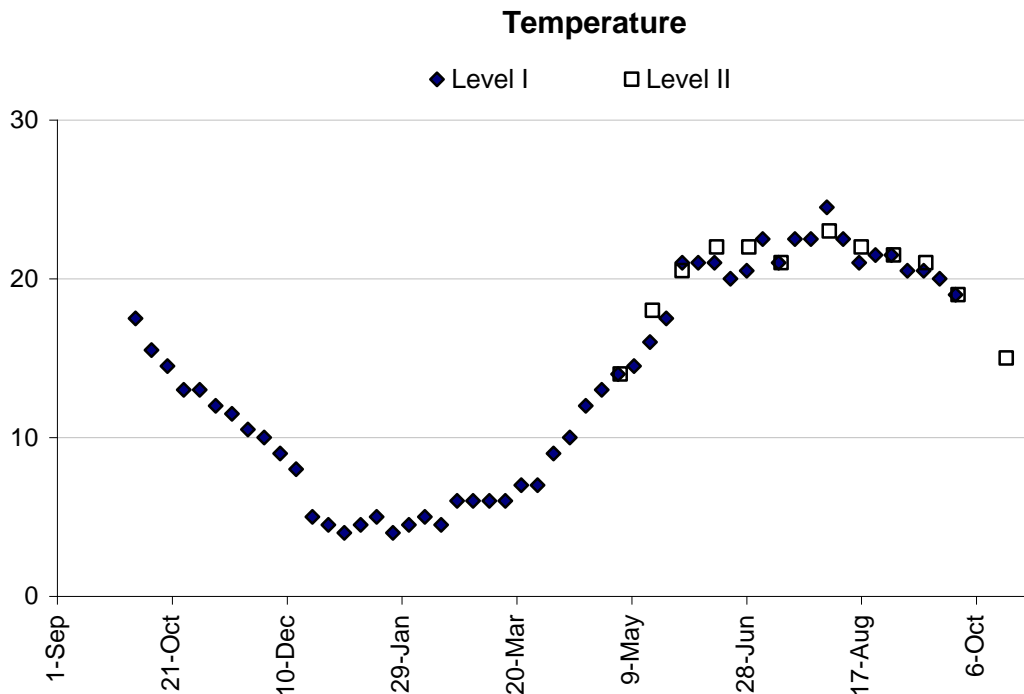
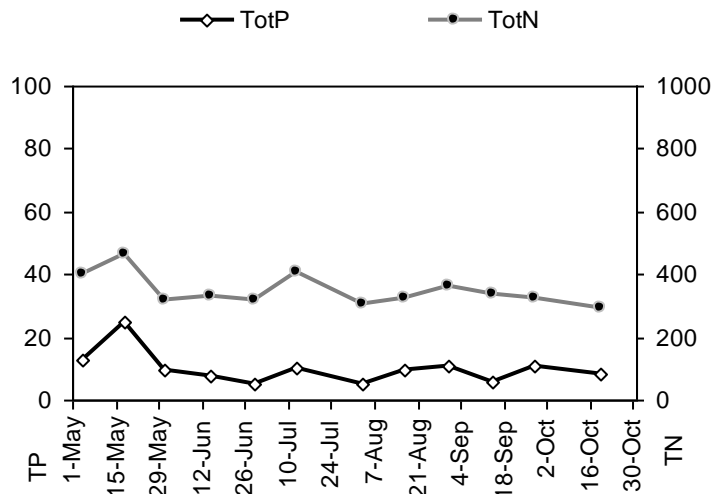


Figure 3. Angle Lake Water Temperatures

## ***Nutrient and Chlorophyll Analysis***

Phosphorus and nitrogen are naturally occurring elements necessary in small amounts for both plants and animals. However, many actions associated with residential and commercial development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is in general limited by the amount of available phosphorus. Increases in phosphorus concentrations thus can lead to more frequent and dense algae blooms – a nuisance to residents and lake users, and a potential safety threat if blooms become dominated by species that can produce toxins. Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth.

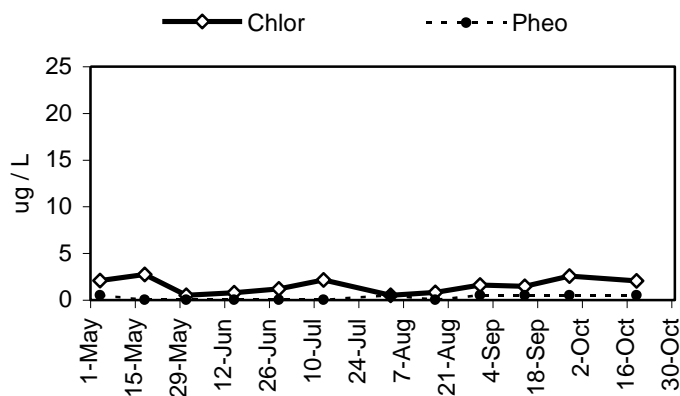
Total phosphorus (TP) and total nitrogen (TN) varied little throughout the May – October sampling period (Figure 4) in 2009, with small peaks in May and July recorded.



**Figure 4. Angle Lake Nutrients**

The ratio of nitrogen (N) to phosphorus (P) can be used to determine if conditions are favorable for the growth of cyanobacteria (bluegreen algae) that can impact beneficial uses of the lake. When N:P ratios are below 20, cyanobacteria can dominate the algal community due to their ability to take nitrogen from the air. The N:P ratio in Angle Lake for this water year ranged from 18.8 to 64.2 with an average ratio of 40.1. This ratio suggests that conditions in the lake were not favorable for bluegreen algae blooms in 2009 except for one period in mid-May, when phosphorus increased more than nitrogen.

Chlorophyll *a* values were low throughout the spring and early summer at Angle Lake (Figure 5). This indicates that phytoplankton populations remained relatively low throughout the sampling season. Pheophytin, which is a degradation product of chlorophyll, remained below detection limits throughout the majority of the season.



**Figure 5. Angle Lake Chlorophyll *a* and Pheophytin Concentrations**

Profile data indicate that thermal stratification was present early in the season and persisted through the summer (Table 1). The deep water samples had significantly lower temperatures, as well as elevated levels of nutrients and detectable ammonia, all of which suggest that the hypolimnion (bottom water) of Angle Lake becomes anoxic during summer, facilitating internal phosphorus release from the sediments.

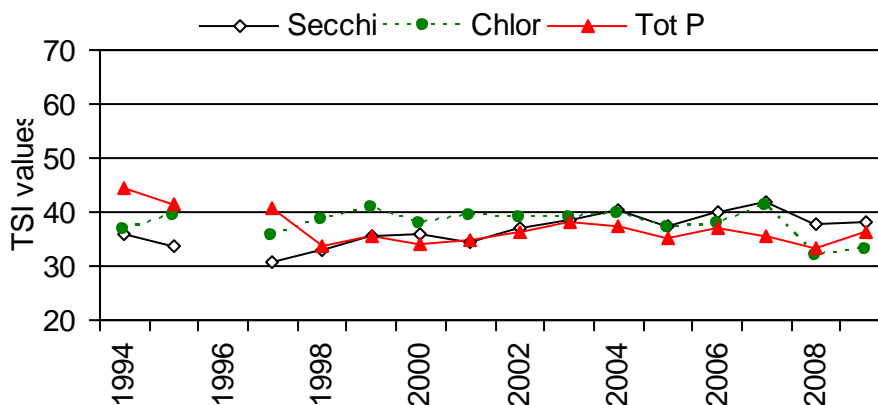
The relatively low values for UV254 indicate that the water of the lake is clear, with little coloration from organic substances, while the total alkalinity values show that the water in the lake is soft and only very lightly buffered from pH change. NOTE: In Table 1, <MDL stands for “below minimum detection level” of the analytical method.

**Table 1: Angle Lake Profile Sample Analysis Results**

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NO2-3	NH3	Total P	OPO4	UV254	Total Alk
Angle	5/18/09	5.0	1	18.0	2.8	<MDL	0.465	0.010	0.011	0.0248	0.0023	0.045	14.9
			8	11.0	10.1	<MDL	0.346			0.0140			
			14.5	8.0			0.653	0.022	0.237	0.0932	0.0303		
Angle	8/31/09	5.5	1	21.5	1.6	<MDL	0.366	<MDL	<MDL	0.0111	<MDL	0.042	18.0
			8	18.0	4.9	1.4	0.303			0.0141			
			15	8.0			2.200	<MDL	1.470	0.5400	0.0286		

### ***The Trophic State Index***

A common method of tracking water quality trends in lakes is through calculation of the “trophic state index” (TSI), developed by Robert Carlson in 1977. TSI values predict the biological productivity of the lake based on water clarity (Secchi) and concentrations of TP and chlorophyll *a*. The 2009 indicators for TP and chlorophyll *a* were close to each other in the mid range of oligotrophy, while the Secchi indicator is slightly higher in the upper range of oligotrophy. For Angle Lake the average of the three TSI values are solidly in the oligotrophic range. A possible upward trend in values seen between the years 1998 through 2007 was not substantiated in either 2008 or 2009, when values dropped back to the levels of 2000.



**Figure 6. TSI Values at Angle Lake**

### ***Conclusions and Recommendations***

Based on monitoring data, water quality in Angle Lake appears to be varying around a relatively stable level over the last decade. Nutrients in the lake remain in low concentrations through the season, and the majority of the N:P ratios are high, which makes the conditions in the lake generally unfavorable for bluegreen algae blooms. Continued monitoring of nutrient and chlorophyll concentrations will track conditions to ensure that water quality remains consistent in Angle Lake over time.